UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND
TOXIC SUBSTANCES

MEMORANDUM

SUBJECT: **Human exposure RED Chapter for 1,4-Bis (bromoacetoxy)-2-butene, BBAB**

From: **Siroos Mostaghimi, Ph.D., Environmental Engineer**
Team One
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510C)

To: **Julie Fairfax, PM#36**
Regulatory Management Branch II
Antimicrobials Division (7510C)

Thru: **Winston Dang, Team Leader**
Team One
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510C)

Norm Cook, Chief
Risk Assessment and Science Support Branch (RASSB)
Antimicrobials Division (7510C)

DP Barcode: **D251930**

Pesticide Chemical No.: **035605**

EPA MRID No: N/A

Review Time: 60 Hours

PHED: Yes

EXECUTIVE SUMMARY

According to information provided by the registrant, all BBAB produced is currently used as a slimicide in paper machines or in the preservation of paper coating formulations/chemicals. It is anticipated that most (approximately 80%) of the future production of BBAB will be in the pulp and paper making industry (Drake, 1998).

Additional industry BBAB registered uses include use in oil field injection systems and preservative uses in slurries, emulsions, and water based coatings, such as paint products (Drake, 1998). These uses correspond to the uses provided on the two active labels (e.g., EPA Reg 1448-353 and 1448-374) for BBAB. The following paragraphs describe the use patterns of BBAB.

Paper machine systems may contain in addition to water, starch, and glue other materials which are of nutritive value to the microorganisms. Under these conditions they thrive and form masses of "slime." Slime formation in the machine prevents normal flow of stock suspensions, and interferes in general with the making of paper. The slime problem, therefore, is common in most paper/pulp mills. Sometimes frequent wash ups may be enough to produce slime control. In addition, the application of chlorine or chloramine is also effective in controlling slime in the paper machine (Kirk and Othmer, 1957). It is often necessary to use antimicrobial pesticides (such as BBAB) to keep the slime under control.

Antimicrobials (such as BBAB) are used in oil well operations along with drilling fluids and muds, packer fluids, and secondary oil recovery. Biocides are used to prevent microbial degradation of the starch component of fresh water drilling fluids, and to inhibit the toxic and corrosive hydrogen sulfide production which may cause the oil equipment from corroding.

General preservative additives are added to latex paints, water-based paints, coatings, adhesives, emulsions, pigment slurries and latexes because bacterial action can degrade the components of a product. In-can preservation of formulated products is needed to prevent mold, mildew, and fungus from destroying the product and to prevent growth on the dry film when the product is used. Pigment slurries such as clay slurries require protection from microbial growth during preparation and shipment. Control spoilage is important since enzymes produced by bacteria can cause viscosity loss even after bacteria have been killed. It is therefore necessary to use antimicrobials (such as BBAB) to prevent mold, mildew, and microbial growth.

Currently, chemical-specific handler or postapplication exposure studies that meet Agency guidelines are not available to EPA. Therefore, to estimate handler exposures, surrogate data from Chemical Manufacturers Association (CMA), *Pesticide Handlers Exposure Database (PHED) Version 1.1*, and the U.S EPA's *Residential Exposure Assessment Standard Operating Procedures (SOPs)* were used to estimate exposure. Using surrogate exposure data, application rates from labels, and EPA exposure estimates, exposure doses were evaluated for the scenarios

provided to follow. *CMA* study data were used to evaluate following primary occupational handler scenarios:

- (1) mixing/loading liquids for oil well injection fluid,
- (2) mixing/loading liquids for pulp and paper mills,
- (3) mixing/loading liquids for general preservative use, and
- (4) mixing/loading liquids for paint manufacturing.

Both secondary and residential handler scenarios are only a concern for painting scenarios. The *Pesticide Handlers Exposure Database (PHED) Version 1.1* was used to estimate exposures to paint for the following secondary occupational handler scenarios:

- (5) loading/applying the paint using a paint brush,
- (6) loading/applying the paint with an airless sprayer, and
- (7) applying the paint with an aerosol can.

The *Residential Exposure Assessment Standard Operating Procedures (SOPs) for Paint* (U.S. EPA, 1997) were used to estimate exposures for the following residential handler scenarios for paint:

- (1) loading/applying the paint using a paint brush,
- (2) loading/applying the paint with an airless sprayer, and
- (3) applying the paint with an aerosol can.

Chemical-specific occupational studies are not available to evaluate postapplication exposure doses. Exposure to dry paper and dry paint/stain is expected to be negligible. Postapplication exposures concerns exist. Since the concentrations used in end use products (e.g., oil well injection fluids, paper, preservatives, and paints) are expected to be much less than what is used in formulating or manufacturing products, the handler risks will most likely provide a higher estimate of the overall worker exposure risks.

A use profile has not been completed. Based on the EPA Hazard Identification Assessment Review Committee report, this exposure assessment was conducted using the following information:

- acute and chronic oral RFDs were not required because BBAB is a non food use chemical;
- 100 percent dermal absorption;
- short-, intermediate-, and long-term dermal toxicity endpoints with a
  - LOEL = 4.5 mg/kg/day, and
  - MOE = 300;
- a body weight of 70 kilograms, which represents weight of an adult man;
- the short-term, intermediate-term, and chronic dermal endpoints were evaluated; and

- inhalation exposure was not considered in the paper and oil industry, but was considered with spraying systems using water-based paint. A toxic endpoint was not available for inhalation exposure.

The results of the primary occupational handler assessment for short-, intermediate-, and long-term handler scenarios indicate that dermal MOEs are acceptable (e.g., MOEs >300) for mixing/loading liquids for general pulp and paper, oil well injection fluids, general preservatives, and paints are acceptable as long as enclosed manufacturing systems are in place (e.g., mechanical pump systems).

If liquids are poured in an open system, then concerns may exist depending on the amount of liquid used per day. For example, using an assumption that 1,000 gallons of paint are manufactured per day in an open system, MOEs are unacceptable (MOE = 64). However, if 100 gallons per day of paint are assumed to be manufactured, MOEs are acceptable (MOE = 640). Note that inhalation exposure is negligible because of a low vapor pressure (10^{-6}) in the pulp/paper, oil, general preservative, and paint industries unless mists or sprays are expected to be generated.

The results of the secondary occupational handler assessment indicate that MOEs are unacceptable (MOEs <300) for brushing and spraying paint using an assumption that paint contains the label recommended maximum of 2.5 percent active ingredient. No secondary occupational handler situations are expected for pulp/paper, oil well drilling, and general preservative uses since these handler scenarios use mechanical operations. EPA is concerned about inhalation exposure when spraying paint; however, the registrant has not submitted acceptable inhalation studies.

The results of the residential handler assessment indicate that MOEs are unacceptable (MOEs <300) for brushing and spraying paint. No residential handler situations exist for the pulp/paper, oil well drilling, and general preservative uses. EPA is concerned about inhalation exposure when spraying paint; however, the registrant has not submitted acceptable inhalation studies.

The results of the occupational postapplication assessment indicate that no chemical-specific studies are available. However, dermal and inhalation exposure are likely to be brief compared to the handler assessment. Risks are expected to be less than the handler assessment. Since postapplication dermal and inhalation exposure are likely to be minimal for pulp/paper, oil well drilling, and general preservative uses, no risk assessment was conducted. For painting, no assessment was conducted because all handler application scenarios have unacceptable levels of risk.

The results of the residential postapplication assessment indicate a concern for painting scenarios. For painting, all handler application scenarios have unacceptable levels of risk. Other residential scenarios involving pulp/paper, oil well drilling, and general preservative use are not applicable.

4. OCCUPATIONAL AND RESIDENTIAL EXPOSURE AND RISK ASSESSMENT

A. Occupational and Residential Toxicological Endpoints

An occupational and/or residential exposure risk assessment is required for an active ingredient if (1) certain toxicological criteria are triggered and (2) there is potential exposure to handlers (mixers, loaders, applicators, etc.) during use or to persons entering the treated sites after application is complete. For BBAB, both criteria were met.

(1) Summary of Toxicity Concerns Relating to Occupational and Residential Exposures

(a) Acute Toxicology Categories

Table 1 provides the acute toxicity categories for BBAB. These data are presented by toxicity test, test results, and toxicity category.

Table 1. Acute Toxicity Categories for BBAB

Test	Results	Toxicity Category
Acute Oral Toxicity	LD50 = 292 mg/kg (male rat) LD50 = 163 mg/kg (female rat) LD50 = 220 mg/kg (both sexes)	II
Acute Dermal Toxicity	LD50 >2,000 mg/kg	III
Acute Inhalation Toxicity	NA	NA
Primary Eye Irritation[1]	NA	I
Primary Dermal Irritation[1]	NA	I
Dermal Sensitization[1]	NA	I

NA = not applicable. An acceptable study is not available.

[1] Although there are no toxicity values are available, this chemical should be classified as Toxicity Category I because of potential eye and dermal irritation, and dermal sensitization.

(b) Other Endpoints of Concern

The endpoints of concern selected by the Review Committee for assessing occupational and residential risk are presented in Table 2. The endpoints for dermal risks are presented as LOAEL (lowest observed adverse effect level). Because the toxic endpoint is a LOAEL, an MOE of 300 is required. Acceptable studies were not available to determine toxic endpoints for

inhalation and cancer risks. Dietary risks are not applicable because BBAB is a non-food use chemical.

Table 2. Endpoints for Assessing Occupational and Residential Risk for BBAB

ENDPOINT	LOEL	MOE	EFFECT
Short-term Dermal Exposure (1-7 days)	4.5 m/kg/day	300	(a)
Intermediate-term Dermal Exposure (7 days - several months)	4.5 mg/kg/day	300	(a)
Long-term Dermal Exposure	4.5 mg/kg/day	300	(a)
Inhalation Exposure	acceptable study not available	NA	NA
Cancer	acceptable study not available	NA	NA
Acute, Chronic Dietary (RFD)	NA	NA	NA

NA = not applicable.
(a) Hyperkeratosis and hyperplasia of the non glandular mucosa of the stomach in both sexes of the Sprague Dawley rats and edema of the stomach in the females only.

Due to the low vapor pressure (10^{-6}), inhalation risk assessment is not required when evaluating the paper and oil industry uses of BBAB. However, for water-based paint use, when painting with a spraying system (e.g., sprayer), inhalation may be a potential exposure route. Because there are no acceptable inhalation studies, a toxic endpoint was not selected for the inhalation exposure route.

(c) Dermal Absorption

According to the Hazard Identification Review Committee report, 100 percent dermal absorption should be used in the risk assessment because of the chemicals' corrosivity.

B. Occupational Exposures and Risks

(1) Handler Exposures and Risks

(a) Occupational Handlers

EPA has determined that there is a potential for exposures to mixers, loaders, applicators, or other handlers during usual use-patterns associated with BBAB. There are potential exposures from use in commercial and industrial settings. Based on the use pattern, EPA has identified two levels of occupational handler exposures and their corresponding exposure scenarios. The exposure scenarios are presented in detail in Table 3 and are briefly described as follows:

- *primary handlers* -- persons in a manufacturing setting who are handling BBAB pesticide products for use as a slimicide in paper machines, in the preservation of papermaking coating formulations/chemicals, in oil field injection systems, in pulp and paper mills, and as a preservative in slurries, emulsions, and water based coatings, such as paints.

- *secondary handlers* -- persons in a residential or commercial setting who are handling paint products to which BBAB has been added.

According to information provided by the registrant, all BBAB produced is currently used as a slimicide in paper machines or in the preservation of paper coating formulations/chemicals. In addition, it is anticipated that most of the future production of BBAB will be in the pulp and paper making industry (Drake, 1998).

Although this use pattern has been confirmed by industry, the current labeling for this product (EPA Reg. 1448-374) indicates that BBAB may be used in oil well injection systems and as a preservative of water-based coatings (e.g., used as a general preservative and paint). Because the paint scenario has greater potential routes of exposure and risks, this assessment has been divided into both non-paint and paint uses.

Note that all secondary handler and residential handler situations involve the use of BBAB in paints. EPA is concerned about paint uses, especially when a spraying system is used. If the registrant intends to support paint uses, then additional inhalation toxicity information may be required to support these uses.

Four exposure scenarios for **primary** occupational handlers have been identified by EPA, including:

Non-Paint Scenarios

(1) mixing/loading liquids for oil well injection fluid,
(2) mixing/loading liquids for general preservative use, and
(3) mixing/loading liquids for pulp and paper mills.

Paint Scenario

(4) mixing/loading liquids for paint manufacturing

Three major paint exposure scenarios for **secondary** occupational handlers including:

(5) loading/applying the paint using a paint brush,
(6) loading/applying the paint with an airless sprayer, and
(7) applying paint with an aerosol can.

Table 3 provides a description of exposure scenarios for occupational/residential handlers.

Table 3. Exposure Scenarios for Occupational/Residential Handlers

Exposure Scenario	Scenario Description
NON-PAINT SCENARIOS	
Occupational Primary Handler	
(1) mixing/loading liquids for oil well injection fluid	Scenario occurs with the use of drilling fluids and muds, packer fluids, and secondary oil recovery. Exposure occurs when adding liquid preservative to the fluid handling system (i.e., the first water/oil separation vessel). Loading is usually via a mechanical pump. Exposure occurs during delivery and filling of bulk tanks, transfer from treating trucks, and during chemical pump maintenance. CMA data for general preservatives for pour liquid and pump liquid are used (CMA, 1992).
(2) mixing/loading liquids for general preservative use	Scenario occurs at the beginning of the general preservative (i.e., emulsions, adhesives, coatings) manufacturing process. The biocide is added either by open pouring or a automated metering system. Exposure occurs either via loading and filling of bulk tanks, contact with pipes, or hoses or setup/maintenance of the automated metering system. CMA data for general preservatives for pour liquid and pump liquid are used (CMA, 1992) .
(3) mixing/loading liquids for pulp and paper mills	Scenario occurs during pulp and paper making. The biocide is added in a recirculating water system through a metering pump. Exposure occurs either via loading and filling bulk tanks, contact with pipes, or hoses, exposure to mists from the paper machines, or setup/maintenance of the automated metering system. CMA data for pulp and paper for pump liquid are used (CMA, 1992) .
PAINT SCENARIOS	
Occupational Primary Handler	
(4)mixing/loading liquids for paint manufacturing	Scenario occurs at the beginning of the paint manufacturing process. The biocide is added either by open pouring or a automated metering system. Exposure occurs either via loading and filling of bulk tanks, contact with pipes, or hoses or setup/maintenance of the automated metering system. CMA data for general preservatives for pour liquid and pump liquid are used (CMA, 1992) .
Occupational/ Residential Secondary Handler	
(5) loading/applying the paint using a paint brush	Scenario occurs when an individual paints indoors or outdoors with a paintbrush. PHED mixer/loader/applicator data for applying liquids with a paintbrush is used (PHED, 1997).
(6) mixing/loading/applying liquid with an airless sprayer	Scenario occurs when an individual paints outdoors with an airless sprayer. PHEDmixer/loader/applicator data for an airless sprayer were used in this assessment (PHED, 1997).
(7) Applying paint with an aerosol can	Data only available for a residential handler. Scenario occurs when an individual paints indoors or outdoors with an aerosol can.

(b) Homeowner Handlers

Based on the potential for paint use patterns, EPA has identified four major exposure scenarios for **secondary** residential handlers of paint including:

(1) loading/applying the paint using a paint brush,
(2) loading/applying the paint with an airless sprayer, and
(3) applying the paint with an aerosol can.

The scenarios are similar to the occupational secondary handlers, except that the residential handlers are expected to handle less of the product per day.

(2) Handler Data and Assumptions

In the course of development of this Re-registration Eligibility Decision Document (RED), limited handler exposure data were available. In the absence of chemical-specific data for BBAB, the Chemical Manufacturers Association (CMA) data and surrogate data from the Pesticide Handlers Exposure Database (PHED) were used to estimate unit exposure. BBAB labeling information along with EPA estimates were used to determine the approximate amount of active ingredient handled per day. These data were used to predict handler exposures for the various scenarios (PHED, 1997; CMA, 1992; and U.S. EPA, 1997). For more details please refer to Appendix A.

(c) Estimated Amount Handled

Table 5 provides the assumptions used to estimate the amount of BBAB handled per day. The sources for these assumptions are presented in Table 5. The estimated amounts handled per day were used in conjunction with data from PHED, the residential SOPs or CMA to yield exposure dose estimates for handlers in various scenarios.

(3) Handler Risk Assessment and Characterization

(a) Handler Exposure and Non-Cancer Risk Calculations

Handler exposure assessments are completed by EPA using a baseline exposure scenario and, if required, increasing levels of risk mitigation (personal protective equipment (PPE) and engineering controls) to achieve an appropriate margin of exposure or cancer risk. The baseline scenario generally represents a handler wearing a long-sleeved shirt, long pants, socks, and shoes with no respirator or chemical-resistant gloves. PPE scenarios generally represent handlers wearing one or more of the following PPE: double layer clothing, chemical-resistant gloves, and/or a respirator. Engineering controls generally represent the use of closed systems for mixing/loading.

Primary handlers -- Exposure to occupational primary handlers is assessed in Table 6. The CMA study is considered most appropriate for the antimicrobial uses of BBAB. The CMA study reports two risk mitigation methods (open pouring of liquid using gloves and pumping liquid using gloves). Open pour scenarios represent a baseline scenario and pump liquids represent a typical engineering control scenario. For some scenarios, such as pulp and paper, only mechanical engineering practices are used. Note that CMA does not provide a PPE scenario for use in their data set. These two risk mitigation methods are provided in Table 6. Note that there are no primary residential uses.

Secondary handlers -- The PHED database is used to assess exposure to secondary handlers applying BBAB using a paint brush, airless sprayer, and aerosol can. The CMA study does not assess these secondary exposures, so PHED data is used. Table 7 presents the exposure/risk calculations at baseline for secondary handlers using the following information: PHED data (PHED, 1997) for secondary occupational handlers and the PHED data reported in the residential SOPs (U.S. EPA,1997) for secondary homeowner handlers. Table 8 presents the exposure/risk calculations with PPE in addition to baseline attire for secondary occupational handlers. Generally, the use of PPE and engineering controls are not considered acceptable options for products sold for use by homeowners, because they are generally not available and/or are inappropriate for the exposure scenario (e.g., acceptability rationale is based on a lack of enforcement, available PPE, and training). Engineering controls for secondary occupational handler uses were also not available for the types of application equipment used in this assessment.

This assessment assumes that the body weight of adults is 70 kg. PHED, CMA, and residential SOPs, were used to assess dose calculations. Values are expressed in two significant figures, but carried out as whole numbers.

Table 5. Exposure Estimates/Assumptions of BBAB for Daily Amount Handled

Exposure Scenario	Pounds of Active Ingredient Handled Per Day
NON-PAINT	
Primary Handler	
(1) mixing/loading liquids for oil well injection fluid	Assumes 1,000 barrels (42,000 gallons) of oil well injection water treated per day . EPA Reg 1448-353 indicates that 5.5 ounces of Slimacide V-10 are used per 1,000 barrels of water. Slimacide V-10 contains 80% active ingredient (ai) and has a density of 14.5 lb/gal. The conversion to pounds ai is 5.5 ounces/128 ounces per gallon x 0.8 (e.g. 80% ai) x 14.5 lb/gal. The total active ingredient is 0.5 lb ai handled per day.
(2) mixing/loading liquids for general preservative use	Assumes 1,000 gallons of general preservative treated per day. EPA Reg 148-353 indicates that a maximum of 0.5% Slimacide V-10 can be added to a water based coating. The density is 14.5 lb/gal and it is 80% ai. The conversion to lb ai is 1,000 gallons x 0.005 (e.g. 0.5.% of product) x 0.8 (e.g. 80% ai) x 14.5 lb/gal. The total active ingredient is 58 lb ai handled per day.
(3) mixing/loading liquids for pulp and paper mills	Assumes 100 tons of pulp are treated per day. EPA Reg 148-353 indicates that a maximum of 0.30 lb of Slimacide V-10 is added per ton of paper (e.g. pulp). The conversion to lb ai is 100 tons x 0.3 lb per ton x 0.8. The total active ingredient is 24 lb ai handled per day.
PAINT	
Primary Handler	
(4) mixing/loading liquids for paint manufacturing	Assumes 100/1000 gallons of paint treated per day. EPA Reg 1448-353 indicates that a maximum of 2.5% of Slimacide V-10 is added in paint. The density of Slimacide V-10 is 14.5 lb/gal and it is 80% ai. The conversion to lb ai is 100/1000 gallons x 0.003 (e.g., 0.3% product) x 0.8 (e.g. 80% ai) x 14.5 lb/gal. The total active ingredient is 3.5/35 lb ai handled per day.
Secondary Handler and Residential handler	
(5) loading/applying the paint using a paint brush	Assumes that 5 gallons of paint are used per day for an occupational painter and 2 gallons for a homeowner. EPA Reg 1448-353 indicates that a maximum of 2.5% of Slimacide V-10 is added as an in-can preservative in paint. The density of Slimacide V-10 is 14.5 lb/gal and it is 80% ai. The conversion to lb ai is 5 gallons occupational painter (2 gallons homeowner painter) x 0.025 (e.g., 2.5% product) x 0.8 (e.g. 80% ai) x 14.5 lb/gal. The total active ingredient is 1.5 lb ai handled per day for an occupational painter and 0.58 lb ai handled per day for a homeowner painter.
(6) mixing/loading/applying liquid with an airless sprayer	Assumes that 50 gallons of paint are used per day for an occupational painter and 15 gallons for a homeowner. EPA Reg 1448-353 indicates that a maximum of 2.5% of Slimacide V-10 is added as an in can preservative in paint. The density of Slimacide V-10 is 14.5 lb/gal and it is 80% ai. The conversion to lb ai is 50 gallons occupational painter (15 gallons homeowner painter) x 0.025 (e.g., 2.5% product) x 0.8 (e.g. 80% ai) x 14.5 lb/gal. The total active ingredient is 15 lb ai handled per day for an occupational painter and 4.4 lb ai handled per day for a homeowner painter.
(7) Applying paint with an aerosol can	Assumes that 3 cans (12 oz per can) of aerosol paint are sprayed per day. EPA Reg 1448-353 indicates that a maximum of 2.5% of Slimacide V-10 is added as an in can preservative in paint. The density of Slimacide V-10 is 14.5 lb/gal and it is 80% ai. The conversion of lb ai is 36 oz/128 oz per gallon x 0.025 (e.g., 2.5% product) x 0.8 (e.g. 80% ai) x 14.5 lb/gal. The total active ingredient is 0.082 lb ai handled per day for an occupational and homeowner painter.

* Personal communication from Siroos. 0.3% manufacturing in can paints.

Table 6: Exposure Assessment to Primary Occupational Handlers

Scenario	Operation	UE[a] (mg/lb ai)	Amount Treated Per Day	Use Rate[b]	Amount AI Handled (lb ai /day)	BW (Kg)	Daily Dose[c] (mg/kg/day)	MOE[d] (LOEL = 4.5 mg/kg/d)
NON-PAINT								
Mixing/loading liquids for oil well injection	Open-pour liquids	0.14	1,000 barrels	0.5 lb ai/ 1,000 barrels	0.5	70	0.0010	4,500
Mixing/loading liquids for oil well injection	Pump liquids	0.0075	1,000 barrels	0.5 lb ai/ 1,000 barrels	0.5	70	0.000054	83,000
Mixing/loading liquids for general preservative use	Open-pour liquids	0.14	1,000 gallons	0.058 lb ai/gallon	58	70	0.12	38
Mixing/loading liquids for general preservative use	Pump liquids	0.0075	1,000 gallons	0.058 lb ai/gallon	58	70	0.0062	730
Mixing/loading for pulp and paper mills	Pump liquids	0.0039	100 tons	0.24 lb ai/ton	24	70	0.0013	3,500
PAINT								
Mixing/loading liquids for paint manufacturing	Open-pour liquids	0.14	100/1000 gallons	0.035 lb ai/gallon	3.5/35	70	0.007/ 0.07	640/64
Mixing/loading liquids for paint manufacturing	Pump liquids	0.0075	100/1000 gallons	0.035 lb ai/gallon	3.5/35	70	0.00038/ 0.0038	12000/1200

[a] UE = Unit Exposure (dermal + inhalation) was derived from the CMA antimicrobial exposure data base (open-pour and pump liquid with gloves). Although the unit exposure values from the CMA data base represent combined dermal and inhalation exposure, the inhalation contribution is low (typically below the limit of detection) and will therefore not significantly affect the estimated exposure values used in this dermal exposure assessment. However, because of the high inhalation toxicity, inhalation exposure and toxicity data are required to allow accurate assessment of inhalation risk concerns (CMA, 1992).

[b] Use Rate (Lb ai/day) was derived from the concentration used in antimicrobial product labels.

[c] Daily Dose = (UE x lb ai/day x 1.0 (ABS))/70. Assuming 100% dermal absorption (e.g.,ABS 1.0).

[d] MOE= LOEL (mg/kg/day) / dermal daily dose (mg/kg/day)

Table 7: Exposure Assessment to Secondary Occupational and Residential Handlers Loading/Applying Paint at Baseline

Scenario	Dermal UE[a] (mg/lb ai)	Inhalation UE[a] (µg/lb ai)	Amount Paint Applied	Amount AI Handled (lb ai/day)	BW (Kg)	Dermal Daily Dose[c] (mg/kg/day)	Inhalation Daily Dose[d] (mg/kg/day)	Dermal MOE[e] (LOAEL = 4.5 mg/kg/d)	Inhalation MOE[f] (NOAEL =? mg/kg/d)
Occupational Handlers									
Loading/applying paint with a paint brush	180	280	5 gal/day	1.5	70	3.9	0.0060	1.2	NA
Loading/applying with an airless sprayer	39	830	50 gal/day	15	70	8.4	0.18	0.5	NA
Loading/applying with an aerosol can	187	1,300	3 12-ounce cans	0.082	70	0.22	0.0015	21	NA
Residential Handlers									
Loading/applying paint with a paint brush	230	280	2 gal/day	0.58	70	1.9	0.0023	2.4	NA
Loading/applying with an airless sprayer	79	830	15 gal/day	4.4	70	5.0	0.052	0.9	NA
Loading/applying with an aerosol can	220	2400	3 12-ounce cans	0.082	70	0.26	0.0028	17	NA

NA = Not applicable, data not available to make calculation.

[a] UE = Unit exposure for occupational handlers was derived from PHED Version 1.1, May, 1997 "Best Available Grades"(PHED, 1997). Unit exposure for residential handlers was derived from Standard Operating Procedures (SOPs) for Residential Exposure Assessments (EPA, 1997).

Occupational handlers

Paint brush- A,B,C grades for dermal and hands, C grade for inhalation, and medium confidence in data. Dermal, hands, and inhalation= 15 reps.

Airless painting- acceptable grades, C grade for inhalation, and high confidence in data. Dermal, hands, and inhalation = 15 reps.

Aerosol spray- acceptable grades, high confidence in data. Dermal, hands, and inhalation = 15 reps.

Residential handlers

Paint brush- A,B,C grades for dermal, inhalation and hands, and medium confidence in data. Dermal and inhalation= 30 reps and hands= 15 reps

Airless painting- B grade for dermal and hands and C grade for inhalation, and high confidence in dermal and hands and medium confidence in inhalation data. Dermal, inhalation and hands = 15 reps.

Aerosol spray- A,B,C grades for dermal, inhalation and grade A for hands, and medium confidence in dermal, hands, and inhalation data. Dermal and inhalation= 30 reps and hands= 15 reps.

[b] Dermal daily dose (mg/kg/day) = [(Dermal UE (mg/lb ai) x lb ai/day x 1.0 ABS Factor]/ BW (kg)

[c] Inhalation daily dose (mg/kg/day) = [(Inhalation UE (µg/lb ai) x lb ai/day x CF (1 mg/ 1000 µg) x 1.0 ABS Factor] / BW (kg)

[d] MOE= LOAEL (mg/kg/day) / dermal daily dose (mg/kg/day)

[e] MOE= LOAEL (mg/kg/day) / inhalation daily dose (mg/kg/day); NOAEL or LOAEL not provided for inhalation exposure

Table 8: Exposure Assessment to Secondary Occupational Handlers Loading/Applying Paint Using PPE

Scenario	Dermal UE[a] (mg/lb ai)	Inhalation UE[a] (µg/lb ai)	Amount Handled (lb ai /day)[b]	BW (Kg)	Dermal Daily Dose[c] (mg/kg/day)	Inhalation Daily Dose[d] (mg/kg/day)	Dermal MOE[e] (LOAEL =4.5 mg/kg/d)	Inhalation MOE[f] (LOAEL =? mg/kg/d)
Occupational Handlers								
Loading/applying paint with a paint brush	22	28	1.5	70	0.47	0.0006	10	NA
Loading/applying with an airless sprayer	8.7	83	15	70	1.9	0.018	2.4	NA
Loading/applying with an aerosol can	41	130	0.082	70	0.048	0.00015	94	NA

NA = not applicable, data not available to make calculation.

[a] UE = Unit exposure for occupational handlers was derived from PHED Version 1.1, May, 1997 "Best Available Grades"(PHED, 1997). Unit exposure for residential handlers was derived from Standard Operating Procedures (SOPs) for Residential Exposure Assessments (EPA, 1997).
Occupational handlers
Paint brush- A,B,C grades for dermal and hands, C grade for inhalation, and medium confidence in data. Dermal, hands, and inhalation= 15 reps.

Airless painting- acceptable grades, C grade for inhalation, and high confidence in data. Dermal, hands, and inhalation = 15 reps.
Aerosol spray- acceptable grades, high confidence in data. Dermal, hands, and inhalation = 15 reps.
Residential handlers
Paint brush- A,B,C grades for dermal, inhalation and hands, and medium confidence in data. Dermal and inhalation= 30 reps and hands= 15 reps

Airless painting- B grade for dermal and hands and C grade for inhalation, and high confidence in dermal and hands and medium confidence in inhalation data. Dermal, inhalation and hands = 15 reps.
Aerosol spray- A,B,C grades for dermal, inhalation and grade A for hands, and medium confidence in dermal, hands, and inhalation data. Dermal and inhalation = 30 reps and hands = 15 reps.

[b] Use Rate (lb ai/day) was derived from the concentration used in antimicrobial product labels.

[c] Dermal daily dose (mg/kg/day) = [(Dermal UE (mg/lb ai) x lb ai/day x 1.0 ABS Factor]/ BW (kg)

[d] Inhalation daily dose (mg/kg/day) = [(Inhalation UE (µg/lb ai) x lb ai/day x CF (1 mg/ 1000 µg) x 1.0 ABS Factor] / BW (kg)

[e] MOE= LOAEL (mg/kg/day) / dermal daily dose (mg/kg/day)

[f] MOE= LOAEL (mg/kg/day) / inhalation daily dose (mg/kg/day); LOAEL not provided for inhalation exposure

(i) Total Daily Dose

The potential daily dermal and inhalation dose was calculated using a 70 kg body weight and a 100% dermal and inhalation absorption value. Note that the CMA combined dermal and inhalation exposure in one unit exposure value, while PHED separated the dermal and inhalation unit exposure values. The general equation for calculating the daily dose using CMA data reported in Table 6 is as follows:

$$Total\ Daily\ Dose\left(\frac{mg\ ai}{Kg/day}\right) = Unit\ Exposure\left(\frac{mg\ ai}{lb\ ai}\right) \times Use\ Rate\left(\frac{lb\ ai}{day}\right) \times \left(\frac{1}{Body\ Weight\ (kg)}\right)$$

Unit Exposure (mg ai/lb ai)= Values obtained from CMA (CMA, 1992)
Use Rate (lb ai/day)= Values from Table 5
Body weight (kg)= 70 kg

(ii) Dermal Daily Dose

The general equation for calculating dermal daily dose in Tables 7 and 8 was calculated using the following formula:

$$Daily\ Dermal\ Dose\left(\frac{mg\ ai}{Kg/day}\right) = Unit\ Exposure\left(\frac{mg\ ai}{lb\ ai}\right) \times Use\ Rate\left(\frac{lb\ ai}{day}\right) \times \left(\frac{1}{Body\ Weight\ (kg)}\right)$$

Unit Exposure (mg ai/lb ai)= Values obtained from PHED (PHED, 1997)
Use Rate (lb ai/day)= Values from Table 5
Body weight (kg)= 70 kg

(iii) Inhalation Daily Dose

The general equation for calculating daily inhalation dose in Tables 7 and 8 was calculated using the following formula:

$$Daily\ Inhalation\ Dose\left(\frac{mg\ ai}{Kg/day}\right) = Unit\ Exposure\left(\frac{\mu g\ ai}{lb\ ai}\right) \times CF\left(\frac{1mg}{1{,}000\ \mu g}\right) \times Use\ Rate\left(\frac{lb\ ai}{day}\right) \times \left(\frac{1}{Body\ Weight\ (kg)}\right)$$

Unit Exposure (µg ai/lb ai)= Values obtained from PHED (PHED, 1997)
CF= Conversion factor (mg/µg)
Use Rate (lb ai/day)= Values from Table 5
Body weight (kg)= 70 kg

(iv) Margin of Exposure (MOE)

The calculations of the daily dermal dose of BBAB received by handlers is used to assess the dermal risk to handlers. The MOE was calculated using a dermal LOEL of 4.5 mg/kg/day. The following formula describes the calculation of the MOE:

$$MOE = \frac{LOAEL \left(\frac{mg}{kg/day} \right)}{Potential\ Daily\ Dose \left(\frac{mg}{kg/day} \right)}$$

(c) <u>Handler Non-Cancer Risks from Dermal Exposures to BBAB</u>

Acute, sub-chronic, and chronic toxicity endpoints related to dermal exposures to BBAB have been identified. A MOE of greater than 300 for BBAB is considered to indicate no risk concern for short-term, intermediate-term exposures, and for chronic exposures. The results presented in Table 6 are summarized in the following bulleted categories.

<u>Primary Occupational Handler Scenarios with Non-Cancer Risk Concerns (Short-term, Intermediate-term, and Long-term Risk)</u>

The calculations indicate that MOEs are less than <u>300</u> for the following scenarios (Table 6):

- Mixing/loading liquids for paint manufacturing: open-pour liquids (assuming 1,000 gallons used)
- Mixing/loading liquids for general preservative use: open-pour liquids

The calculations indicate that MOEs are more than <u>300</u> at baseline for the following scenarios:

- Mixing/loading liquids for injection wells: pump liquids
- Mixing/loading liquids for injection wells: pump liquids
- Mixing/loading liquids for pulp and paper mills: pump liquids
- Mixing/loading liquids for general preservative use: pump liquids
- Mixing/loading liquids for paint manufacturing: pump liquids
- Mixing/loading liquids for paint manufacturing: open-pour liquids (assuming 100 gallons)

Secondary Occupational/Residential Handler Scenarios with Non-Cancer Risk Concerns (Short-term, Intermediate-term, and Long-term Risk)

The calculations of short-term and intermediate-term risks indicate that MOEs are less than 300 at **baseline** for all scenarios:

- (5) loading/applying the paint using a paint brush,
- (7) loading/applying the paint with an airless sprayer, and
- (8) applying the paint with an aerosol can.

The calculations indicate that MOEs are less than 300 **with additional PPE** for the following scenarios:

- (5) loading/applying the paint using a paint brush,
- (7) loading/applying the paint with an airless sprayer, and
- (8) applying the paint with an aerosol can.

Data Gaps

Data gaps exist for:

- Scenarios involving inhalation exposure

Data Quality and Confidence in Assessment

Several issues must be considered when interpreting the occupational exposure risk assessment. These include:

- The handler assessments were completed using "low grading quality" CMA data due to the lack of a more acceptable data set for the primary occupational handler.

- PHED and SOP data includes data for chemicals other than antimicrobial pesticides and the job functions may be different from those where antimicrobial chemicals are applied.

(d) Handler Non-Cancer Risks from Inhalation Exposures to BBAB

No toxicity endpoints have been identified for inhalation exposure.

(4) Occupational Postapplication Exposures and Assumptions

EPA has determined that there are potential exposure concerns relating to post-application exposures to BBAB. There are potential exposures following applications in commercial, industrial, and residential settings. EPA has identified two levels of postapplication exposures:

(a) Primary Occupational Postapplication Exposures

EPA has identified BBAB exposure scenarios for primary occupational post-application exposures in commercial, industrial settings, including both dermal and inhalation exposure. The exposure scenarios include:

- (1) exposures following BBAB to open vats of hot liquids, such as paper-pulp, coatings, emulsions, oil well injection fluid, and paints; and

- (2) exposures to persons maintaining industrial equipment which contains product treated with BBAB (e.g., drilling equipment, water treatment systems, and paper/pulp mills).

No postapplication data are available to directly assess postapplication exposures in the occupational setting. However, postapplication dermal exposures from BBAB use-patterns are likely to be minimal because of highly diluted BBAB solutions. In addition, postapplication exposures are likely to be brief. Since postapplication dermal exposures are likely to be minimal compared to handler exposures, no risk assessment is required.

(b) Secondary Occupational Postapplication Exposures

EPA has identified BBAB exposure scenarios for secondary occupational postapplication exposures in commercial, industrial settings, including both dermal and inhalation exposure. The exposure scenarios include:

- (1) exposures to persons occupying areas recently painted or stained with BBAB products; and

- (2) exposures to persons occupying areas where BBAB containing paper products are being manufactured.

Presently no chemical-specific occupational studies are available to evaluate postapplication exposure doses. Exposure resulting from contact with dry paper and dry paint/stain is expected to be negligible. Since the concentrations used in end use products (e.g., oil well injection fluids, paper, preservatives, and paints) are expected to be much less than formulating or manufacturing products, the handler risks will most likely provide a higher estimate of the overall worker exposure risks. Since handler risks are unacceptable for all painting scenarios, postapplication issues will not be addressed.

(5) Residential Postapplication Exposure and Risk Characterization

(a) Primary Postapplication Exposures

EPA has identified no major BBAB exposure scenario for primary homeowner postapplication exposures, since at this time all pesticide products are intended primarily for occupational use.

(b) Secondary Postapplication Exposures

Based on the use patterns, EPA has identified one BBAB exposure scenario for secondary homeowner postapplication exposures including:

- (1) exposures while occupying areas recently painted with BBAB paint.

Presently no chemical-specific occupational studies are available to predict postapplication exposure doses. Exposure resulting from dry paint/stain is expected to be negligible. Since handler risks are unacceptable for all painting scenarios, postapplication issues will not be addressed.

(6) Uncertainties and Limitations

A use-profile has not been completed for BBAB. In the absence of the profile, information from BBAB labels (e.g., EPA Reg 1448-353 and 1448-374) has been used to identify probable use scenarios for BBAB. These may have to be adjusted when the BBAB use-profile is completed.

At this time, BBAB chemical specific handler or post-application exposure studies that meet Agency guidelines have not been identified. Surrogate dermal and inhalation data from the Pesticide Handlers Exposure Database (PHED) Version 1.1,Chemical Manufacturers Association (CMA) database, and draft Standard Operating Procedures (SOPs) for Residential Exposure Assessments were used to assess handler exposure.
In addition, note that CMA surrogate data have the following deficiencies:

- The inhalation concentrations were typically below the detection limits, so the unit exposures for the inhalation exposure route could not be accurately calculated.

- The quality of the CMA data were assessed using the same grading criteria as PHED and the grades were all at C,D,E lower than PHED standards (e.g., most of PHED is at grades A,B,C).

- Grade C,D,E data frequently may have QA/QC problems including lack of either/or field fortification, laboratory recoveries, and storage stability information.

- Grade C,D,E data has an insufficient amount of replicates.

- Grade C,D,E data may have higher variabilities (e.g., high CVs).

The following deficiencies of PHED and the residential SOPs should also be noted:

- Data includes all pesticides not just antimicrobial chemicals, so the results reported in PHED may be misleading.

- Pesticides are not usually volatile, so inhalation unit exposures may be underestimated for antimicrobial chemicals that are volatile.

- The job functions that commonly use pesticides may be different from those job functions using antimicrobial chemicals.

- The basic assumption underlying the database is that exposure to pesticide handlers is primarily a function of the physical parameters associated with handling and applying rather than the chemical properties of the individual active ingredients.

Other uncertainties regarding exposure estimates are provide below.

- No acceptable studies are available to assess cancer risks.

- Exposure estimates are performed using traditional EPA/OPP/AD assumptions for amount treated per day (see MBT RED). Specific industry or EPA estimates were not available.

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File c:\myfiles\Human Exposure RED chapter for BBAB (6-22-2000).wpd

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APPENDIX A

(a) Chemical-Specific Handler Exposure Data

Chemical-specific handler exposure data were not submitted by the registrant for BBAB; therefore, surrogate data from CMA, PHED, and the residential SOPs were used to estimate exposure.

(b) Chemical Manufacturers Association (CMA) Data

The *CMA study* was used to estimate primary exposures for the following occupational handler scenarios:

- (1) mixing/loading liquids for oil well injection fluid,
- (2) mixing/loading liquids for general preservative use,
- (3) mixing/loading liquids for pulp and paper mills, and
- (4) mixing/loading liquids for paint manufacturing.

In response to an EPA Data Call-In Notice, a study was undertaken by the Institute of Agricultural Medicine and Occupational Health of The University of Iowa under contract to the Chemical Manufacturers Association (CMA). In order to meet the requirements of Subdivision U of the Pesticide Assessment Guidelines (superseded by Series 875.1000-875.1600 of the Pesticide Assessment Guidelines), handler exposure data is required from the specific chemical manufacturer registering the antimicrobial pesticide. The applicator exposure study has to comply with the assessment guidelines for "Applicator Exposure Monitoring" in Subdivision U and the "Occupational and Residential Exposure Test Guidelines" in Series 875. CMA submitted a study, "Antimicrobial Exposure Assessment Study (amended December 8, 1992)," on February 28, 1990, for this purpose. The study, conducted by William Popendorf, et al., was evaluated and accepted by EPA Occupational and Residential Exposure Branch (OREB) of Health Effect Division (HED), Office of Pesticides Program (OPP) in 1990. The purpose of the CMA study was to characterize exposure to antimicrobial chemicals to support reregistrations of antimicrobial pesticides (CMA, 1992).

The Agency determined that the CMA study has fulfilled the basic requirements of Subdivision U - Applicator Exposure Monitoring. The advantage of CMA data over other "surrogate data sets" is that seven chemicals were analyzed and the job functions of the mixer/ loader/applicator were defined based on common use and application methods for antimicrobial pesticides. It should be noted that there were a few deficiencies in the study, particularly with respect to grading. The grading in the CMA database is the same standard methods of grading as that used in PHED. The deficiencies were as follows:

- The inhalation concentrations were typically below the detection limits, so the unit exposures for the inhalation exposure route could not be accurately calculated.

- The quality of the CMA data was assessed using the same grading criteria as PHED and the grades were C,D,E, which is lower than PHED standards (e.g., most of PHED grades are A,B,C).

- Grade C,D,E data frequently may have QA/QC problems, which includes lack of either/or field fortification, laboratory recoveries, and storage stability information.

- Grade C,D,E data have an insufficient number of replicates.

- Grade C,D,E data may have higher variabilities (e.g., high CVs).

Exposure results from the CMA study seem to indicate that dermal exposure is the primary exposure route for the seven antimicrobial chemicals analyzed. Inhalation exposure in the CMA data were very low, usually below the chemical limit of detection. Since the inhalation exposures were so low, the inhalation exposure was combined with the dermal exposure to produce one unit exposure value. Since BBAB is not a volatile chemical, CMA data is adequate to assess these exposure routes.

(c) <u>Pesticides Handlers Exposure Database (PHED) Data</u>

The *Pesticide Handlers Exposure Database (PHED) Version 1.1* was used to estimate exposures for the following secondary occupational handler scenarios:

- (5) loading/applying the paint using a paint brush,
- (6) loading/applying the paint with an airless sprayer, and
- (7) applying the paint with an aerosol can.

PHED was designed by a task force consisting of representatives from the U.S. EPA, Health Canada, the California Department of Pesticide Regulation, and member companies of the American Crop Protection Association (PHED, 1997). PHED is a generic database containing measured exposure data for workers involved in the handling or application of pesticides in the field (i.e., currently contains data for over 2,000 monitored exposure events). The basic assumption underlying the system is that exposure to pesticide handlers can be calculated using monitored data because exposure is primarily a function of the physical parameters of the handling and application process (e.g., packaging type, application method, and clothing scenario). PHED also contains algorithms that allow the user to complete surrogate, task-based exposure assessments beginning with one of the four main data files in the system (i.e., mixer/loader, applicator, flagger, and mixer/loader/applicator).

Users can select data from each major PHED file and construct exposure scenarios that are representative of the use of the chemical. However, to add consistency to the risk assessment process, the EPA, in conjunction with the PHED Task Force, has evaluated all data within the system and developed surrogate exposure tables that contain a series of standard unit exposure

values for various exposure scenarios. These standard unit exposure values are based on the "best fit" values calculated by PHED. "Best fit" exposure values are calculated in PHED by assessing the distributions of exposures for each body part included in data sets selected for the assessment (e.g., chest or forearm). A composite exposure value is then calculated that represents the entire body. PHED categorizes distributions as normal, log normal, or in any "other" category. Generally, most data contained in PHED are log normally distributed or fall into the PHED "other" distribution category. If the distribution is log normal, the geometric mean for the distribution is used as the "best fit" exposure value. If the data are an "other" distribution, the median value of the data set is used in the calculation of the "best fit" exposure value. As a result, the surrogate unit exposure values that serve as the basis for this assessment generally range from the geometric mean to the median of the selected data set. PHED unit exposure data used in this assessment represent the estimated level of exposure expected per unit amount of pesticide handled and are reported in units of mg exposure/lbs ai pesticide handled (PHED, 1998).

Each study in PHED has been graded from "A" to "E" according to certain QA/QC factors including field recovery, laboratory recovery, storage stability, data variability, data correction based on recovery, and number of replicates. The Agency has a higher confidence in the PHED data that meets grades A,B,C (PHED, 1998). The grading system is illustrated in Table 4.

Data confidence refers to both the **quality** and the **amount** of data for each PHED run. Each study in PHED has been graded from "A" to "E" according to certain Quality Assurance/Quality Control (QA/QC) factors (PHED, 1998).

Table 4. Grading PHED Studies

Data Grade	% Lab Recovery	CV* for Lab recovery	% Field Recovery	% storage Stability	Data Corrected For:***
A	90-110	#15	70-120	**	Field Recovery
B	80-110	#25	50-120	**	Field Recovery
C	70-120 70-120	#33 #33	30-120 or missing	** 50-120	Field Recovery
D	60-120	#33	**	**	Field Recovery if available; if not then storage stability, if not then lab recovery
E	**Does not meet above criteria**				

Data Grade	% Lab Recovery	CV* for Lab recovery	% Field Recovery	% storage Stability	Data Corrected For:***

***** CV = Coefficient of Variation
****** Does not matter if available or missing
******* If a field recovery of 90% or greater is obtained, no correction of the data is necessary

High Confidence Run/:

Grades A and B **-AND-** at least 15 replicates per body **AB GRADE/15 Reps** part. PHED runs having any combination of A or B grade data are listed as "AB grade" data in the tables.

Medium Confidence Run:

Grades A, B, or C **-AND-** at least 15 replicates per body **ABC GRADE/15 Reps** part. PHED runs having any combination of A, B, and C grade data are listed as "ABC grade" data in the tables.

Low Confidence Run/:

Any run that includes D or E grade data **- OR -** has less **"ALL GRADE"** than 15 replicates per body part. PHED runs which include "D" or "E" grade data are referred to as having **"ALL GRADE" data**. "ALL GRADE" data are always low confidence.

Because data for painting scenarios were not reported in the CMA study, PHED data were used to estimate the secondary exposure scenarios. PHED has been used for a long period of time as a source data surrogate for handler exposure assessments. The data for PHED may be more advantageous to CMA data in that it is generally rated as grades A,B,C. Therefore, it tends to have better quality QA/QC (e.g. better field, lab and storage stability recoveries), more replicates (e.g. over 15 replicates), less variability (e.g. lower CVs), and reportable inhalation unit exposure values. The following deficiencies of PHED should be noted:

- Data includes all pesticides not just antimicrobial chemicals, so the results reported in PHED may be misleading.

- Pesticides are not usually volatile, so inhalation unit exposures may be underestimated for antimicrobial chemicals that are volatile.

- Job functions that commonly use pesticides may be different from those job functions using antimicrobial chemicals.

- The basic assumption underlying the database is that exposure to pesticide handlers is primarily a function of the physical parameters associated with handling and applying rather than with the chemical properties of the individual active ingredients.

(d) Residential Exposure Assessment Standard Operating Procedures (SOPs)

The *Residential Exposure Assessment Standard Operating Procedures (SOPs)* (U.S. EPA, 1997) was used to estimate exposures for the following secondary residential handler scenarios:

- (1) loading/applying the paint using a paint brush,
- (2) loading/applying the paint with an airless sprayer, and
- (4) applying the paint with an aerosol can.

The residential exposure assessment SOPs are designed to assess exposure to pesticides in a residential setting. The objective of these SOPs is to provide standard default methods for developing residential exposure assessments for both handler and postapplication exposures when chemical- and/or site-specific field data are limited. These methods may be used in the absence of, or as a supplement to, chemical- and/or site-specific data. The SOPs were prepared by EPA's Office of Pesticide Programs, Health Effects Division and Antimicrobial Division with input from EPA's Office of Pollution Prevention and Toxics, and Office of Research and Development (U.S. EPA, 1997).

For the residential handler exposure assessment, dermal and exposure data came from the Residential SOPs developed using PHED version 1.1. The values of the residential PHED data versus the occupational PHED data generally differ because the baseline clothing is different. The

baseline residential clothing attire selected for the baseline residential scenario is short pants, short-sleeve shirt, socks and shoes and no gloves. The occupational baseline scenario generally represents a handler wearing a long-sleeved shirt, long pants, socks, and shoes with no respirator or chemical-resistant gloves. The grading scheme for the residential PHED data is described in the occupational section. Residential handler data will be presented in the same data tables as the occupational handler.